REMARKS

The Office Action, mailed February 22, 2006, objected to claims 3-6, rejected claims 1, 2, 7, 8, 12 and 13, and allowed claims 9, 10, 14 - 19. The Office Action further confirmed claim 11 is withdrawn from consideration following an earlier restriction requirement. Upon entry of the present amendment, claims 3-6, 9, 10, and 14-19 are pending in the present application and are under consideration.

Applicants also amend the specification to refer to the provisional application no. 60/442,459, filed on January 22, 2003 pursuant to the requirement of MPEP 201.11 at 200-53 (8th ed. rev. 2, May 2004) and to be consistent with the filing receipt. The official filing receipt for this application, mailed on 01/23/2004, states that this application claims benefit to 60/442,459 filed on 01/22/2003. An English translation of the Chinese language provisional application and a statement that the translation is accurate are also submitted herein pursuant to MPEP 201.11 at 200-54 (8th ed. rev. 2, May 2004).

In this paper, Applicants have canceled claims 1, 2, 7, 8, 11, 12, and 13 without prejudice to or disclaimer of the subject matter recited therein. Applicants reserve the right to pursue the subject matter of those claims in this or a related application. In addition, as specifically described below, Applicants have amended claim 3 to be in independent form as suggested by the Office. Office Action at page 3.

I. Objection to claims 3 - 6

The Office objected to dependent claims 3 - 6 and stated these claims would be allowed if presented in independent form. Office Action at page 3. Applicants thank the office for this suggestion. They have been adopted. Accordingly, Applicants amend

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claim 3 to be an independent claim, with claims 4 - 6 now dependent on independent claim 3.

II. Rejection of Claim 1 Under 35 U.S.C. § 102(b)

The Office rejected claim 1 under 35 U.S.C. § 102(b), as allegedly being anticipated by JP 63216472. Office Action at page 2. Solely to expedite prosecution and without acquiescing to the Office's rejection, Applicants have canceled claim 1 and reserve the right to pursue the subject matter of claim 1 in this or a related application. Therefore, the rejection of claim 1 is now moot.

III. Rejection of Claims 1, 2, 12, 13 Under 35 U.S.C. § 102(b)

The Office also rejected claims 1, 2, 12, and 13, as allegedly being anticipated by JP 2002086188. Office Action at page 2. Solely to expedite prosecution and without acquiescing to the Office's rejection, Applicants have canceled claims 1, 2, 12, and 13 and reserve the right to pursue the subject matter of these claims in this or a related application. Therefore, the rejection of claims 1, 2, 12, and 13 is now moot.

IV. Rejection of Claims 7 - 8 Under 35 U.S.C. § 103(a)

The Office rejected claims 7 - 8 under 35 U.S.C. § 103(a), as allegedly being unpatentable over JP 63216472. Office Action at page 2. Solely to expedite prosecution and without acquiescing to the Office's rejection, Applicants have canceled claims 7-8 and reserve the right to pursue the subject matter of these claims in this or a related application. Therefore, the rejection of claims 7 - 8 is now moot.

CONCLUSION

Applicants respectfully assert that claims 3 - 6, 9 - 10, and 14 - 19 are in condition for allowance and request that the Office issue a timely Notice of Allowance.

If the Office does not find the claims to be allowable, the undersigned requests that the Office calls her at (650) 849-6607 to set up an interview.

Please grant any extensions of time required to enter this Amendment and charge any additional required fees to Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

Dated: May 15, 2006

By: Anna Y. Tsang
Anna Y. Tsang by Jean B Fordis
Reg. No. 48,003 Reg. No 32,984

OIPE IAP56
MAY 1 5 2006
PATENT & TRADEMARK OFFICE

Date: May 9th, 2006

CERTIFICATION OF TRANSLATION

I hereby certify that the following Chinese to English translation of Provisional Patent Application Number 60/442,459, entitled "Zero-Discharge of Water Glass Effluents By Alkaline Biotreatment Techniques" is an accurate and complete rendering of the contents of the source document to the best of my knowledge. I further certify that I translated and edited said document and that I am a qualified professional competent in both languages with more than _8__ years of experience in Chinese to English technical translation.

By: ______________________
Signature of Translator

TsungChia-Hao
Printed Name of Translator

9Fl., No. 112, Sec. 2, Chang-An E. Rd., Taipei 104, Taiwan
Address of Translator

Signed before me this ___ day of __________, 2006 by ________________.

____
Signature of Witness

____
Printed Name of Witness

案號：
Case No. 1129 日期：
Date: MAY 0 9 2006
本文件之簽名或蓋章，在臺灣臺北地方法院所屬民間公證人陳建源事務所認證。 公證人 陳 建 源
Attested at the Cheng, Chien-Yuan Notary Public Office, Taiwan Taipei District Court, R.O.C., that the signature(s)/seal(s) in this document is/are authentic.

Notary Public

Cheng, Chien-Yuan

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Taipei, Taiwan
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OIPE IAP56
MAY 15 2006
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Development Center for Biotechnology (DCB) Patent Application Form

DCB Patent Application Number: ____________________

Invention Name (Chinese): Zero-discharge of water glass wastewater by alkaline bio clarification

Invention Name (English): Zero-discharge of water glass effluents by alkaline biotreatment

Name and Number of the Project for Patent Application:

Inventor	Worker number	Project belonged	Tel. No.	
1. Wu Hsiao, Ru-Ron	0327	Environment Bio Project	27396446	Inventor representative: Wu Hsiao, Ru-Ron
2. Yeh, Meu-Hsien	0696	Environment Bio Project	27396446	Countries in which the patent application will be filed: ROC, Japan, U.S.A., Canada, EU, P.R.C.
3. Lin, Hsiu-Ping Pearl	1100	Environment Bio Project	27325123	Fund Source (Fund Number): 092ET001.ET60
4.				Estimate Cost: NTD$750,000

1. The invention:
a. is going to be or has been published as a thesis ☐yes when: ______ ■no

b. is going to be or has been technical transferred to other firms ☐yes when: ______ ☐no
Firm name(s):______ Contract name: ______

c. is publicly introduced or demonstrated ■yes ☐no

2. The project to which the invention belongs (Project name, Contract number, Firm name, and Right belonging)
■ Ministry of Economic Affairs Science and Technology Project: ☐ Industrial Service Commission Project (owned by both DCB and commission firms?)

☐ DCB Project: ☐ Other project:

3. The idea of the invention was recorded in DCB lab note:
Number: LR4572 Page: p.322671-322700
LR4693 p.329318-329400

4. Patent search
a. Keywords: Na_2SiO_3 or "water glass" or "sodium silicate" & wastewater & biological & dye

b. Databases searched: USPTO, JPO, WIPO and ESPTO

c. Related patents or publication (patent number or document information):
JP01159098, KP55149121, and JP1027325

5. Background of the invention: (prior arts and their defects)
Water glass Na_2SiO_3 is basic (pH>12), and water glass wastewater is also basic (usually pH > 11). The pH of wastewater varies with the content of water glass inside. The pH of water glass wastewater produced in the dyeing industry is up to 11.5. Water glass wastewater will solidify or form solid water glass suspension when the pH is lowered, even when the pH adjustment is slight. As a result, the water glass wastewater clarification treatments published in patents and documents worldwide are all physical and chemical treatments. The cost is high and the feasibility is low.

6. Purpose of the invention: (problem to be solved)
Water glass forms a large amount of sludge. Once water glass wastewater enters a neutral bio treatment pond, it will solidify or form solid water glass suspension. If physical or chemical treatment is employed, chemical coagulation sludge or glass water sludge will form. Taking the water glass wastewater produced by the dyeing industry as an example, one ton of water glass wastewater will form 0.3 tons of water glass sludge. This will cause the cleaning and transportation of sludge to be very difficult, block on-site pipes, result in serious effect on the efficiency of on-site active sludge treatment and chemical coagulation treatment, etc. In the present invention, water glass wastewater is directly bio clarified without adjusting the pH. No water glass sludge will form and water resources and water glass are then recovered.

7. Detailed description of the invention: (embodiments and examples)

Basophilic decomposing bacteria population is fixed on support and used under water environment of pH 10.5~12.5 for decomposing the contaminant component in water glass wastewater. Bio purified wastewater is then distilled or acidified, solidified and compressed to recycle water resources and water glass.

8. Comparison of the results between the present invention and prior arts (including the comparison of benefit)

Currently, water glass wastewater is treated by conventional wastewater treatment in industry. However, such wastewater will solidify or form solid water glass suspension once it enters a neutral bio treatment pond. If physical or chemical treatment is employed, chemical coagulation sludge or glass water sludge will form. Water glass Na_2SiO_3 is basic (pH>12), and water glass wastewater is also basic (usually pH > 11). The pH of wastewater varies with the content of water glass inside. The pH of water glass wastewater produced in the dyeing industry is up to 11.5. The water glass wastewater clarification treatments published in patents and documents worldwide are all physical and chemical treatments. Taking the water glass wastewater produced by the dyeing industry as an example, one ton of water glass wastewater will form 0.3 tons of water glass sludge. This will cause the cleaning and transportation of sludge to be very difficult, block on-site pipes, result in serious effect on the efficiency of on-site active sludge treatment and chemical coagulation treatment, etc.

In the present invention, water glass wastewater is directly bio clarified without adjusting the pH. Water resources and water glass are then recycled. The pH during bio purification process is extremely high (usually between 10.5~12.5) and such bio purification process is not seen in patents and documents worldwide. The present invention is a "zero-discharge" and "100% recovery" bio clarification and recovery method.

9. Claim

A bio clarification method for zero-discharge of water glass wastewater, comprising (1) a technique of clarifying a contaminant component in water glass (Na_2SO_3) under a basic environment by alkalophilic bacteria, and (2) a method for removing or recovering water glass (Na_2SO_3) from water glass (Na_2SO_3) wastewater.

10. Patent requisites (novelty, improvement, and industrial application)

In the present invention, water glass wastewater is directly bio clarified without adjusting the pH. Water resources and water glass are then recycled. The pH during bio purification process is extremely high (usually between 10.5~12.5) and such bio purification process is not seen in patents and documents worldwide. The present invention is a "zero-discharge" and "100% recovery" bio clarification and recovery method.

11. Strategy considered

Forming patent portfolio and restraining competitive firms.

12. Analysis of economic benefit (comparison to current techniques, anticipated number of firms to license, target market and scale of the market)

Taking a short fiber textile dyeing factory with wastewater discharge of 250 CMD water glass wastewater as an example, the estimated construction cost of an extra alkaline bio clarification unit is 25 million New Taiwan (NT) dollars, and the annual operation cost is about 300,000 NT dollars. 25.44 million NT dollars of the operating expense of the conventional wastewater treatment currently used in industry for treating water glass wastewater would be saved each year. The annual net profit (sum of savings – operation expense) is 25.14 million NT dollars. It is estimated that the construction cost of the alkaline bio clarification unit can be recouped in the first year.

Countersign Body	Applying Department		
Law Affair and Intellectual Property Management Group	Vice CEO	Project Leader	Applicant

Invention Name (Chinese): Zero-discharge of water glass wastewater by alkaline bio clarification
Invention Name (English): Zero-discharge of water glass effluents by alkaline biotreatment

Inventor: Wu Hsiao, Ru-Ron; Yeh, Meu-Hsien;
Lin, Hsiu-Ping Pearl
Presenter: Wu Hsiao, Ru-Ron
January 16, 2004

Background of the Invention

- Water glass Na_2SiO_3 is basic (pH>12) and water glass wastewater is also basic (usually pH > 11). The pH of wastewater varies with the content of water glass.
- The pH of water glass wastewater produced in the dyeing industry is up to 11.5. Water glass wastewater will solidify or form solid water glass suspension when the pH is lowered, even when the pH adjustment is slight.
- As a result, the water glass wastewater clarification treatments published in patents and documents worldwide are all physical and chemical treatments. The cost is high and the feasibility is low.

Purpose of the Invention

- Water glass solidifies at about a neutral environment. Taking the water glass wastewater produced by the dyeing industry as an example, one ton of water glass wastewater will form 0.3 tons of water glass sludge. Large amounts of water glass sludge will cause the cleaning and transportation of sludge to be very difficult, block on-site pipes, result in serious effect on the efficiency of on-site active sludge treatment and chemical coagulation treatment, etc.
- In the present invention, water glass wastewater is directly bio clarified without adjusting the pH. No water glass sludge will form and water resources and water glass are then recovered.

DB

Content of the Invention

- Basophilic decomposing bacteria population is fixed on support and used under water environment of pH 10.5~12.5 for decomposing the contaminant component in water glass wastewater.
- Bio purified wastewater is then distilled or acidified, solidified and compressed to recycle water resources and water glass.

DB

Defect of Prior Art

- Currently, water glass wastewater is treated by conventional wastewater treatment in industry. That is, water glass wastewater is first bio treated then physically and chemically treated.
- However, such wastewater will solidify or form solid water glass suspension once it enters a neutral bio treatment pond. Ineffective sludge will form and affect the treatment of effective bio sludge.
- When the wastewater is then physically and chemically treated, chemically coagulated sludge or water glass sludge will form and block on-site pipes. Large amounts of sludge will need to be cleaned and transported.

DB

Comparison of the Present Invention and Prior arts

- In the present invention, water glass wastewater is directly bio clarified without adjusting the pH. Water resources and water glass are then recycled. The pH during bio purification process is extremely high (usually between 10.5~12.5) and such bio purification process is not seen in patents and documents worldwide. The present invention is a "zero-discharge" and "100% recovery" bio clarification and recovery method.

DB

Claims

- A bio clarification method for zero-discharge of water glass wastewater, comprising (1) a technique of clarifying a contaminant component in water glass (Na_2SO_3) under a basic environment by alkalophilic bacteria, and (2) a method for removing or recovering water glass (Na_2SO_3) from water glass (Na_2SO_3) wastewater.

DB

Patent Requisites (Novelty, Improvement, and Industrial Application)

- In the present invention, water glass wastewater is directly bio clarified without adjusting the pH.
- The pH during bio purification process is extremely high (usually between 10.5~12.5) and such bio purification process is not seen in patents and documents worldwide.
- Recycle water resources and water glass.
- The present invention is a "zero-discharge" and "100% recovery" bio clarification and recovery method.

DB

Strategy Considered

- Form Patent Portfolio
- Restrain Competitive firms

DB

Figure 5 Separation of Wastewater and Water Glass From the Water Glass Wastewater

DB

Figure 6. Recycled water glass obtained from water glass wastewater after bio clarification

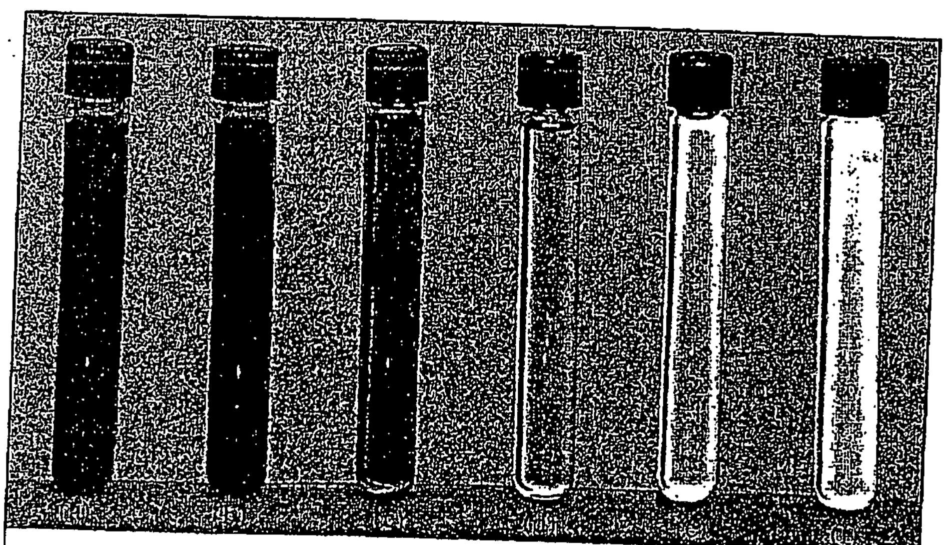

Figure 7. Color comparison of different stages of water glass wastewater undergoing bio clarification

(a) Original water glass wastewater (b)~(e) Effluents in different stages of bio clarification (f) Final effluent

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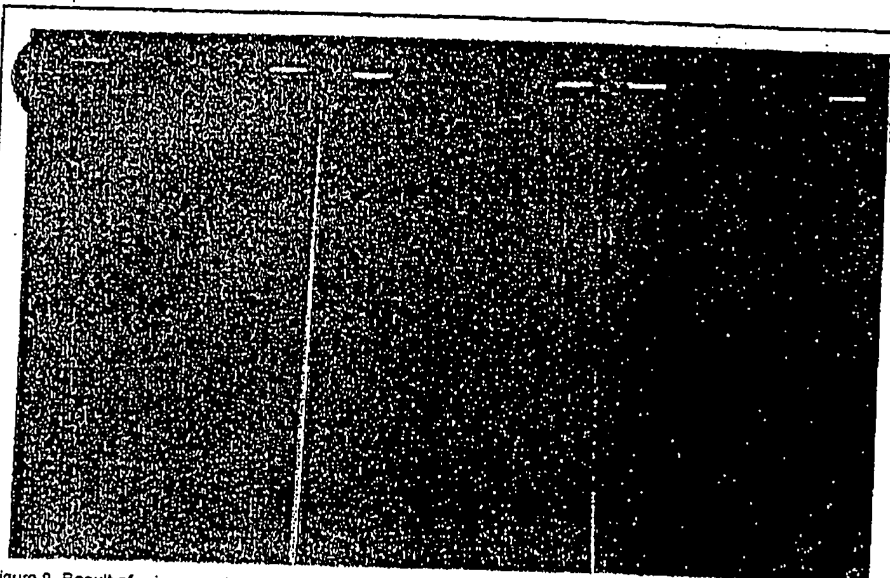

Figure 9. Result of using recycled water glass (obtained from bio purified water glass wastewater) in a dyeing process

Left: Current water glass Middle: 1/2 Current water glass and 1/2 recycled water glass Right: Recycled water glass

Table . Analysis for cost effectiveness of the extra bio clarification unit for treating water glass wastewater

(Unit: New Taiwan Dollars)

Cost items		Water glass wastewater amount
		250 CMD
Expense	Construction expense	25,000,000
	Operation expense (dollar/year)	300,000
Saving (dollar/year)	Acidifying cost	1,260,000
	Wastewater treatment cost	1,860,000
	Outsourcing sludge treatment cost	22,320,000
	Sum of savings	25,440,000
Net profits (sum of savings - Operation expense)		25,140,000
Return term		1 year

Note: 1. Outsourcing sludge treatment cost is calculated based on 1,200 dollar/ton.

2. Presume that the cost of other treatments required for making recycled water glass usable equals to the profit of recycling water glass.

2002 Ministry of Economic Affairs Science and Technology Research and Development Project Execution Achievement Summary Table

Technical Report

Project Name	Environment Biotechnology and Product Research and Development Second Stage Three-year Project (Second year)				
Project Number	※91-EC-2-A-17-0235				
Executive body	Development Center for Biotechnology (DCB)		Executive Period	January 2002 to December 2002	
Project Leader	Lin, Hsiu-Ping Pearl		Project Co-leader		
Project Sub-leader	Lin, Hsiu-Ping Pearl		Contact Number	(02) 27325123	
Report Name	Chinese	Zero-discharge of water glass wastewater by alkaline bio clarification techniques			
	English	Zero-discharge of water glass effluents by alkaline biotreatment techniques			
Data Serial Number	※DCB-0235-T103(91)				
Report Writer	Wu Hsiao, Ru-Rong		Yeh, Meu-Hsien		
Report Written Date	December 31, 2002	Written Langue and number of Pages		Chinese, 19 pages	
Classified Until	Month, Date, Year		Classification Level		
Key Words	Zero-discharge (Zero-discharge)				
	Alkaline bio clarification (Alkaline biotreatment)				
	Water glass wastewater (water glass effluents)				

[Translation]

ABSTRACT

Water glass can form large amount of sludge. Once water glass enters a neutral biotreatment pond, it will solidify or form solid water glass suspension. If chemical treatment is employed, chemical sludge or glass water sludge will form. Taking the water glass waste water produced by the cloth printing industry as an example, 1 ton of water glass will form 0.3 tons of water glass sludge. This will cause the cleaning and transportation of sludge to be very difficult, and it will block the on-site pipes, resulting in serious effect on the efficiency of on-site activated sludge treatment and chemical treatment etc. By establishing a basic biotreatment method, where water glass waste water directly undergo biological clarification without prior pH adjustment, water resources and water glass are recycled. Thus, the problematic water glass sludge can be converted to recycled water glass.

Abstract:

Water glass forms a large amount of sludge. Once water glass wastewater enters a neutral bio treatment pond, it will solidify or form solid water glass suspension. If physical or chemical treatment is employed, chemical coagulation sludge or glass water sludge will form. Taking the water glass wastewater produced by the dyeing industry as an example, one ton of water glass wastewater will form 0.3 tons of water glass sludge. This will cause the cleaning and transportation of sludge to be very difficult, block on-site pipes, result in serious effect on the efficiency of on-site active sludge treatment and chemical coagulation treatment, etc. By establishing a new alkaline bio clarification, where water glass wastewater directly undergoes bio clarification without prior pH adjustment, water recourses and water glass are recycled. Thus, the problematic water glass sludge can be converted to recycled water glass.

Writer: ____________________

Zero-discharge of water glass wastewater by alkaline bio clarification techniques

Introduction

Woven textile fabrics dyeing factories have continuous dyeing services (in a first plant) and immersion dyeing services (in a second plant). Main products include pure cotton 19.8%, T/C 22%, PET (containing Nylon) 42%, Tencel 14.2%, etc. Using a calculation based on product type distribution, the one time color agreement rate of 95% and the average water usage per product unit of 65-70 L/kg are quite reasonable.

The current on-site wastewater treatments employ deep bio aeration and chemical coagulation, and the wastewater is divided into two plants to be treated individually by the A-plant and B-plant described in Fig. 1 (A-plant (high concentration) - desizing, mercerizing and steam treating (water glass), and B-plant – dyeing wastewater and cleaning wastewater). The COD of treated wastewater effluent is about 100~300 mg/L. Such COD does not meet the direct discharge standard, but meets the requirement to discharge wastewater to an industry park wastewater treating plant. Since on-site discharge is desired, enhancing wastewater treatment is required to meet the direct discharge standard. Since water glass results in poor efficiency of the wastewater treatment in the A-plant treatment system (see the analytical results in Table 1 and 2), water glass should be treated separately to prevent the diminishing of the total efficiency. The current Bio treatment systems are divided into system A (A plant) and system B (B plant). System A has a water retention time up to 60 hours, and system B has a water retention time up to 13.5 hours. If water glass wastewater is treated separately and systems A and B are put in series, the treatment efficacy of these two systems will be increased.

Method and Material

A. Water Quality Analytical Methods

COD	: Refer to standard Methods 508C. Closed Reflux, Colorimetric Method
MLSS	: Refer to NIEA W210.55A
NH_4^+	: MERCK SQ-118 colorimeter; analytical method number: 14752- Method number 6
PO_4^{3-}	: MERCK SQ-118 colorimeter; analytical method number: 14842- Method number 84
pH	: SUNTEX TS-2 meter

BOD	: Refer to NINE W510.50A
Conductivity	: Refer to NINE W203.51B
VSS	: Standard Method 209D Fixed and Volatile Solids Ignited at 550°C
True color	: Refer to NINE W223.50B
OUR (unfed) test	: Take a water sample (400 ml) from a bio pond. Aerate the sample until saturation is achieved (about five minutes). Transfer the sample to a BOD bottle. Determine the bio oxygen uptake rate of the sample.
OUR (fed) test	: Add a certain amount of wastewater to be entered to the bio pond to a BOD bottle. Take a water sample (400 ml) from a bio pond. Aerate the sample until saturation is achieved (about five minutes). Transfer the sample to the BOD bottle. Determine the bio oxygen uptake rate of the sample.

B. Culturing and Screening Decomposing Microbes for Water Glass Wastewater

1. Place all microbes collected over years directly into water glass wastewater for culturing.
2. Add 15 g of BACTO-AGAR to the "water glass wastewater" with pH maintained at 11.5.
   Autoclave sterilize the BACTO-AGAR containing wastewater and cool to 50°C.
   Divide the cooled product into sterilized Petri dishes in a laminar flow. After the agar coagulates and sterilized culture plates are formed, implant the microbes cultured and screened in the water glass wastewater to the plates.
3. Incubate the plates in an incubator at 30°C, examine after 24 hours, and examine again after 48 hours.

C. Evaluation of the Continuous Bio Treatment of "Water Glass Wastewater" in Laboratory

1. Fix the Decomposing Microbes for "water glass wastewater" on activated carbon and placed the same in a 2.1-liter treatment tank. The Bio activated carbon occupies 80% of the volume of the tank.

2. Continuously flow "water glass wastewater" into and out the tank. Adjust the water retention time in the tank based on the COD, true color value, etc of the wastewater entering the tank. Keep the system stable.
3. For "water glass wastewater" having true color greater than 10000 ADMI, treat the wastewater by using series tanks.
4. Examine the COD, true color, pH, etc periodically.

D. Evaluation of the Continuous Bio treatment of "water glass wastewater" on site

1. Fix the Decomposing Microbes for "water glass wastewater" on activated carbon and placed the same in a 20-liter four-series-tank treatment tanks. The Bio activated carbon occupies 90% of the total volume of the tank.
2. Continuously flow the "water glass wastewater" into and out the tank. Make the water retention time equal to 4.9 days.
3. After the system is stabilized in the laboratory, transfer the system to the wastewater treatment site in a factory and run the system under the conditions used in the laboratory.
4. Examine the COD, true color, pH, etc periodically.

E. Evaluation of the Separation or the Recycle of "Water Glass" and "Water Resources" from "Water Glass Wastewater"

1. Based on the different physical and chemical properties of "water glass" and "water," establish a method for separating or recycling "water glass" and "water resources" from "water glass wastewater."
2. Based on the fact that "water glass" coagulates rapidly at a neutral environment but "water" does not, separate "water glass" from "water."
3. Based on the fact that the boiling points of "water glass" and "water" are different, separate "water glass" from "water."

F. Evaluation of the Usage of "Water Glass" Recycled from "Water Glass Wastewater" in Dyeing Process

1. Based on the fact that "water glass" coagulates rapidly at a neutral environment but "water" does not, separate "water glass" from "water." Liquefy "water glass" by adjusting the pH to basic with NaOH.
   Send the recycled water glass to the technical research department of a dyeing factory for evaluating the usage of recycled water glass in dyeing.
2. Based on the fact that the boiling points of "water glass" and "water" are

different, separate "water glass" from "water."

Adjust the concentration of water glass to the concentration used in the dyeing process.

Send the recycled water glass to the technical research department of a dyeing factory for evaluating the usage of recycled water glass in dyeing.

G. Analysis of Economic Benefit

1. Calculate the construction cost of an alkaline bio clarification unit.
2. Calculate the operation coat of conventional wastewater treatment used in current industry for treating water glass wastewater.
3. Calculate the term to recoup the construction cost of the alkaline bio clarification unit.

Result

A. Analytical results of samples from the pipe terminal treatment

On March 5, 2002, samples were taken from wastewater discharged from an A-plant and a B-plant in a factory by our DCB Environment Bio Project group. Analytical results are shown in Table 1 and Table 2. Since on-site discharge is desired, enhancing wastewater treatment is required to meet the direct discharge standard. Since water glass results in poor efficiency of the wastewater treatment in the A-plant treatment system (see the analytical results of bio oxygen uptake rate, etc in Table 1 and 2), water glass should be treated separately to prevent the diminishing of the total efficiency. The current bio treatment system is divided into system A (A plant) and system B (B plant). System A has a water retention time up to 60 hours and system B has a water retention time up to 13.5 hours. If water glass wastewater is treated separately and systems A and B are put in series, the treatment efficacy of these two systems will be increased.

B. Culturing and Screening Decomposing Microbes for Water Glass Wastewater

1. All microbes collected over years were placed directly into water glass wastewater for culturing.
2. 15 g of BACTO-AGAR was added to the "water glass wastewater" with pH maintained at 11.5.

   The BACTO-AGAR containing wastewater was autoclave sterilized, cooled to 50°C, and divided into sterilized Petri dishes in a laminar flow. After the agar coagulated and sterilized culture plates formed, the microbe containing wastewater of step 1 was implanted to the plates to serve as an experiment. A plate without wastewater was taken to serve as a control.

3. The plates of the experiment and the control were incubated in an incubator at 30°C. After 48 hours, the control plate stayed clean while the experimental plates contained white growth, see Fig. 2. Portions of the agar from the experiment plates were removed and washed with sterilized water. The wash water was observed under a 1000x microscope, and a lot of microorganisms were found.

C. Evaluation Results of the Continuous Bio Treatment of "Water Glass Wastewater"

1. The Decomposing Microbes for "water glass wastewater" were fixed on activated carbon and placed in a 2.1-liter treatment tank. The Bio activated carbon occupied 80% of the total volume of the tank.
2. The "water glass wastewater" was continuously flowed into and out the tank. The water retention time in the tank was adjusted based on the COD, true color value, etc of the wastewater entering into the tank, and the system was kept stable.
3. For "water glass wastewater" having true color greater than 10000 ADMI, the wastewater was treated by series tanks. Decolorization of the wastewater was readily observed from one tank to another tank, see Fig. 7.
4. The COD values of the influents and the effluents were measured, and the decrease in COD values is shown in Fig. 3. Under the water environment of pH 11.5, bio treatment obviously reduced the COD value of the wastewater.
5. The true colors of the influents and the effluents were measured, and the decrease in true colors is shown in Fig. 4. Under the water environment of pH 11.5, bio treatment obviously reduced the true colors of the wastewater to nearly colorless.

D. Evaluation of the Continuous Bio Treatment of Water Glass Wastewater on site

1. The Decomposing Microbes for "water glass wastewater" were fixed on activated carbon and placed in a 20-liter four-series-tank treatment tanks.

The Bio activated carbon occupied 90% of the total volume of the tanks.

2. The "water glass wastewater" was steadily flowed into and out the tank. The water retention time in the tank was 4.9 days.
3. After the system was stabilized in the laboratory, the system was transferred to the wastewater treatment site in a factory and run under the conditions used in the laboratory.
4. The true colors of the influents and the effluents were measured, and the decrease in true colors is shown in Table. 4. Under the water environment of pH 11.5, bio treatment obviously reduced the true colors of the wastewater to nearly colorless.

E. Evaluation of the Separation or the Recycle of "Water Glass" and "Water Resources" from "Water Glass Wastewater"

1. Based on the different physical and chemical properties of "water glass" and "water," a method for separating or recycling "water glass" and "water resources" from "water glass wastewater" was established.
2. Based on the fact that "water glass" coagulates rapidly at a neutral environment but "water" does not, "water glass" was separated from "water." Fig. 5 shows the result of separating "water glass" and "wastewater" directly from the "water glass wastewater." Fig. 6 shows the result of separating "water glass" from "water resources" after the "water glass wastewater" has undergone alkaline bio clarification to reduce its COD and true color value respectively to 35 mg/L and 57 ADMI.
3. Table 5 shows the result of recovering "water glass" after the "water glass wastewater" has undergone alkaline bio clarification to reduce its COD and true color value respectively below 50 mg/L and 60 ADMI. The recovering was based on the fact that the boiling points of "water glass" and "water" are different. Physical and chemical properties of the recycled water glass of different concentration ratios were analyzed. The bio purified effluent distilled to remove 82.5% water has a Na_2O percentage approximating that of the water glass concentration required for dyeing. Recycled water glass with such concentration was applied in the test of using "recycled water glass" in a dyeing process.

F. Evaluation of the Usage of "Water Glass" Recycled from "Water Glass Wastewater" in a Dyeing Process

1. Based on the fact that "water glass" coagulates rapidly at a neutral

environment but "water" does not, "water glass" was separated from "water." The recycled "water glass" was liquefied by adjusting the pH to basic with NaOH and sent to the technical research department of a dyeing factory for evaluating the usage of recycled "water glass" in dyeing. The result was not ideal. Current water glass was used as a control and recycled water glass obtained from step 2 of *E* was used as experiment. After dyeing, the color difference was obvious.

2. Based on the fact that the boiling points of "water glass" and "water" are different, separate water glass from water. The concentration of the recycled "water glass" was adjusted to the concentration used in the dyeing process and the recycled "water glass" was sent to the technical research department of a dyeing factory for evaluating the usage of recycled "water glass" in dyeing. Current water glass was used as a control and recycled water glass obtained from step 3 of *E* was used as experiment. After dyeing, the color difference was still observed; see Fig. 9 and Fig. 10. According to the technical research department of the dyeing factory, the dyeing result was acceptable when the recycled water glass from step 3 of *E* and the current water glass were mixed in a 1:1 ratio for dyeing.

G. Analysis of Economic Benefit

Taking a short fiber textile dyeing factory with the wastewater discharge of 250 CMD water glass wastewater as an example, the estimated construction cost of an extra alkaline bio clarification unit is 25 million New Taiwan (NT) dollars, and the annual operation cost is about 300,000 NT dollars. However, 25.44 million NT dollars of the operating cost of the conventional wastewater treatment currently used in industry for treating water glass wastewater is saved each year (see Table 5). The annual net profit (sum of savings – operation cost) is 25.14 million NT dollars. Therefore, it is estimated that the construction cost of the alkaline bio clarification unit can be recouped in the first year (see Table 6).

Conclusion

Currently, water glass wastewater is usually treated by conventional wastewater treatment in industry. Once water glass wastewater enters a neutral bio treatment pond, it will solidify or form a solid water glass suspension. If physical or chemical treatment is employed, chemical sludge or glass water sludge will form. Since water glass Na_2SiO_3 is basic (pH>12), water glass wastewater is also basic. The pH of wastewater varies with the content of water glass. The pH of water glass wastewater produced in a dyeing factory is up to 11.5. As a result, the water glass wastewater clarification treatments published in patents and documents worldwide are all physical and chemical treatments. Taking the water glass wastewater produced by the dyeing industry as an example, one ton of water glass wastewater will form 0.3 tons of water glass sludge. This will cause the cleaning and transportation of sludge to be very difficult, block on-site pipes, result in serious effect on the efficiency of on-site active sludge treatment and chemical treatment, etc.

In the alkaline bio clarification technique that results in zero-discharge of water glass wastewater, water glass wastewater is directly bio clarified without adjusting the pH. Water resources and water glass are then recovered. Since the pH of wastewater after bio clarification is extremely high (mostly ranges in 10.5 – 12.5), the water glass wastewater bio clarification treatment was not published in patents and documents worldwide. The water glass wastewater bio clarification treatment is a "zero-discharge" and a "100% recovery" bio clarification and recovery method.

Reference

1. **Treatment of organic wastewater from dyeing plant effluents**. Igarashi, Tatsuo (Canon Electroncs, Inc., Japan). Jpn. Kokai Tokkyo Koho (1989), 6pp. CODEN:JKXXAF JP01159098 A2 19890622 Heisei. Patent written in Japanese. Application:JP 87-319817 19871216. CAN 112:204167 AN 1990:204167 CAPLUS

2. **Recovery of water glass from dye wastewater.** (Kimura Kakoki Co.,Ltd.,Japan). Jpn. Kokai Tokkyo Koho (1980), 4pp. CODEN:JKXXAF JP 55149121 Showa. Patent written in Japanese. Application:JP 79-54534 19790502. CAN 94:176608 AN 1981:176608 CAPLUS

Brief Description of Figures and Tables

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Table 1. Analytical results of on-site sample from the pipe terminal treatment in Plant A (March 5, 2002)

	pH	COD (mg/L)	BOD (mg/L)	Conductivity (mS/cm)	True color ADMI	NH_4-N (mg/L)	PO_4-P (mg/L)	OUR (mg/L/h)
PVA wastewater	11.92	1040	370 (360)	3.96	105	0.4	ND	
water glass wastewater	10.42	396	24	14.11	2636	0.1	15.2	
Mixed original wastewater	11.99	2800 (2690)	760 (720)	10.78	1171	0.23	12.2	
Bio tank	9.80	(509)						14.1 $35.1_{(fed)}$
Bio precipitation tank	9.51	(596)	(10)	10.05	1436	0.8	3.90	
Before General chemical coagulation	8.19	586 (294)	3	4.92	1390	0.77	1.77	
After General chemical coagulation	7.06	220 (165)	2.4	5.16	925	2.81	0.47	

Table 2. Analytical results of on-site sample from the pipe terminal treatment in Plant B (March 5, 2002)

	pH	COD (mg/L)	BOD (mg/L)	Conductivity (mS/cm)	True color ADMI	NH_4-N (mg/L)	PO_4-P (mg/L)	OUR (mg/L/h)
Mixed original wastewater	12.04	1382 (1330)	390 (320)	5.27	888	0.27	3.45	
Bio tank	8.01	(211)		3.85	847	0.98	2.68	16.4 $143.5_{(fed)}$
Bio precipitation tank	7.69	(314)	(3)	4.46	1399	0.7	1.69	
Before General chemical coagulation	8.19	586 (294)	3	4.92	1390	0.77	1.77	
After General chemical coagulation	7.06	220 (165)	2.4	5.16	925	2.81	0.47	

Table 3. Analytical results of sample water glass wastewater

	pH	COD (mg/L)	BOD (mg/L)	Conductivity (mS/cm)	True color ADMI
Water glass wastewater	11.5	131(min) 552(max)	5-30	14.11	108(min) 28645(max)

Note: the COD value of the water glass wastewater is only listed for reference, because the COD analysis of the water glass wastewater is subject to interference.

Table 4. Evaluation results of on-site water glass process wastewater treated by the alkaline bio clarification (20-L reaction tank)

Date	days	COD(in)	COD(out)	ADMI(in)	ADMI(out)
11/28	37	242		6076	
11/29	38		15		40
12/2	41	468		9151	
12/3	42		173		53
12/6	45		57		70
12/9	48	728		4226	
12/10	49		15		97
12/12	51	724		4146	
12/13	52		10		99
12/16	55	822		4128	
12/17	56		88		64
12/19	58	751		20653	
12/20	59		22		146

Table 5. Evaluation for the physical and chemical properties of the water glass wastewater that was alkaline bio purified and concentrated

Analysis Item / Sample number	Density	pH	Conductivity (mS/cm)	Na_2O (%)	SiO_2 (%)	SiO_2/Na_2O ratio
Water glass (purchased)	1.3685	11.81	35.0	11.21	26.54	2.37
Bio clarified effluent with 85% water removed	1.3184	11.63	48.4	8.41	19.71	2.34
Bio clarified effluent with 82.5% water removed	1.2717	11.85	48.2	7.56	17.91	2.36
Bio clarified effluent with 80% water removed	1.2262	11.71	47.4	6.64	15.9	2.39
Bio clarified effluent with 70% water removed	1.1006	11.69	45.2	5.35	12.34	2.31
Bio clarified effluent with 60% water removed	1.1309	11.68	40.5	3.97	8.7	2.19
Bio clarified effluent with 50% water removed	1.1047	11.66	35.8	3.22	6.8	2.11
Bio clarified effluent with 40% water removed	1.0791	11.63	32.4	2.72	5.17	1.9

Table 6. Analysis for cost effectiveness of the extra bio clarification unit for treating water glass wastewater (Unit: New Taiwan Dollars)

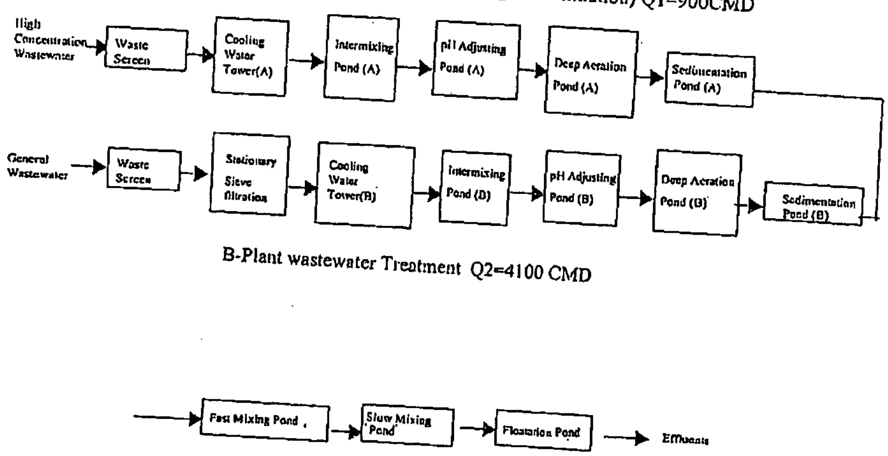
Cost items		Water glass wastewater amount
		250 CMD
Expense	Construction expense	25,000,000
	Operation expense (dollar/year)	300,000
Saving (dollar/year)	Acidifying cost	1,260,000
	Wastewater treatment cost	1,860,000
	Outsourcing sludge treatment cost	22,320,000
	Sum of savings	25,440,000
Net profits (sum of savings - Operation expense)		25,140,000
Return term		1 year

Note: 1. Outsourcing sludge treatment cost is calculated based on 1,200 dollar/ton.

2. Presume that the cost of other treatments required for making recycled water glass usable equals to the profit of recycling water glass.

Figure1. Flow Diagram of On-Site Wastewater Treatment Processes

A-Plant Wastewater Treatment (high concentration) Q1=900CMD



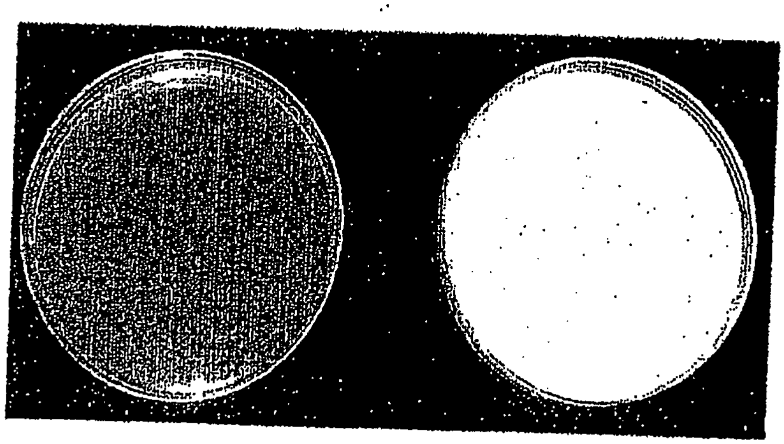


Figure 2. Result of culturing and screening special decomposing microbes for "water glass wastewater, pH 11.5"

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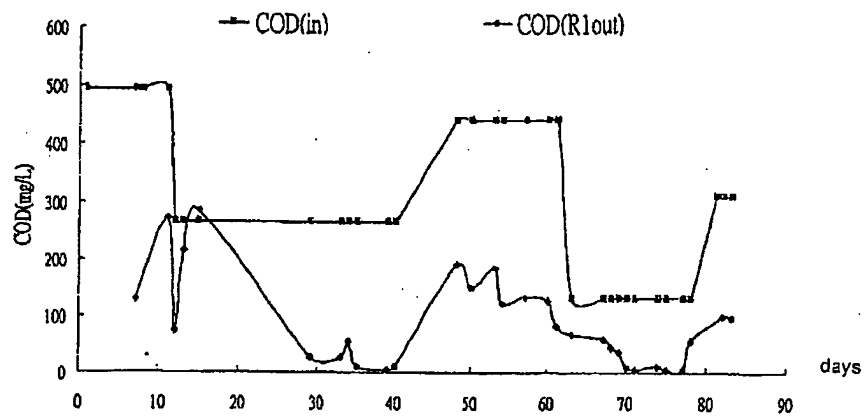

Figure 3. Evaluation of the efficiency in reducing the COD value of water glass wastewater treated by bio treatment

(2.1L reaction tank, 1.5 day)

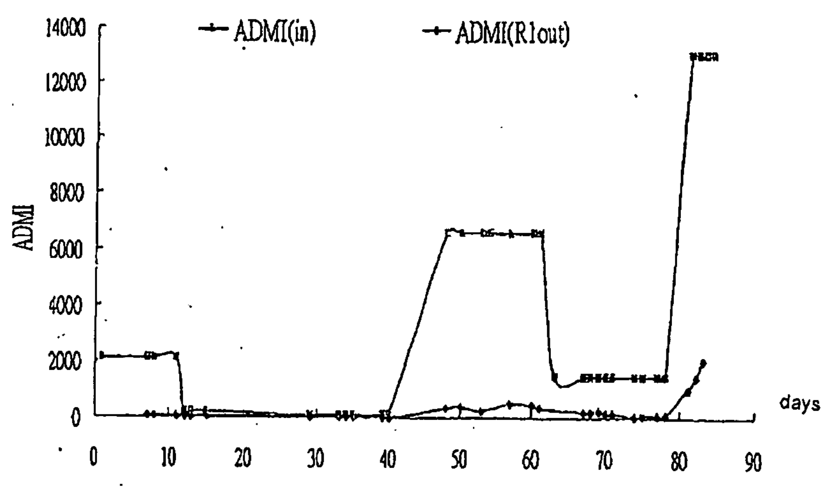

Figure 4. Evaluation of the efficiency in decreasing the ADMI value of water glass wastewater treated by bio treatment

(2.1L reaction tank, HRT 1.5 day)

Figure 5. Separation of wastewater and water glass from water glass wastewater (below)

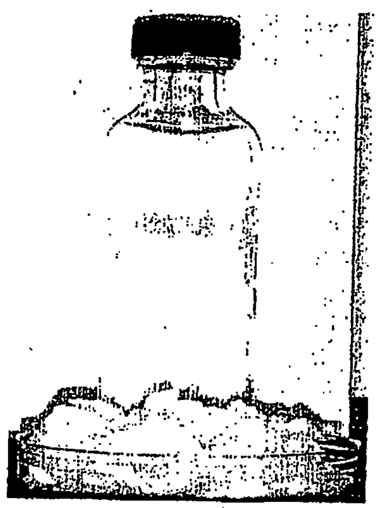

Figure 6. Recycled water glass obtained from water glass wastewater after bio clarification

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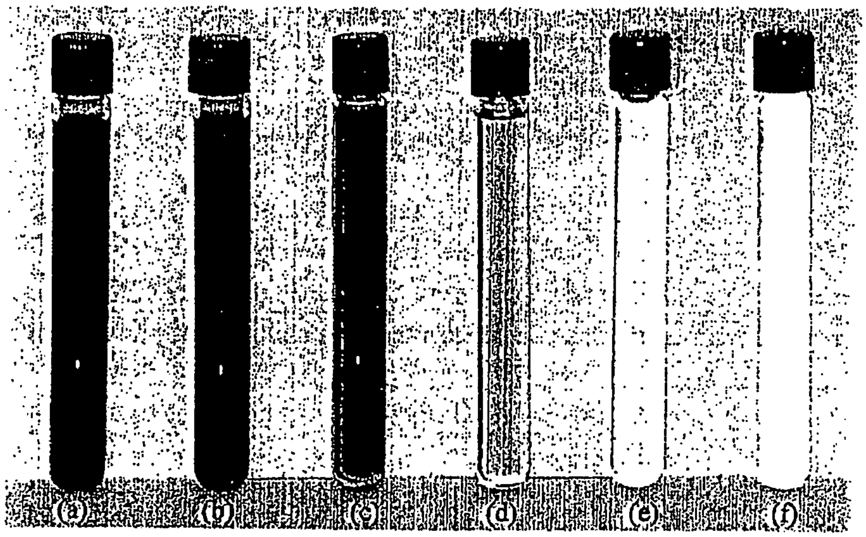

Figure 7. Color comparison of different stages of water glass wastewater undergoing bio clarification

(a) Original water glass wastewater (b)~(e) Effluents in different stages of bio clarification (f) Final effluent

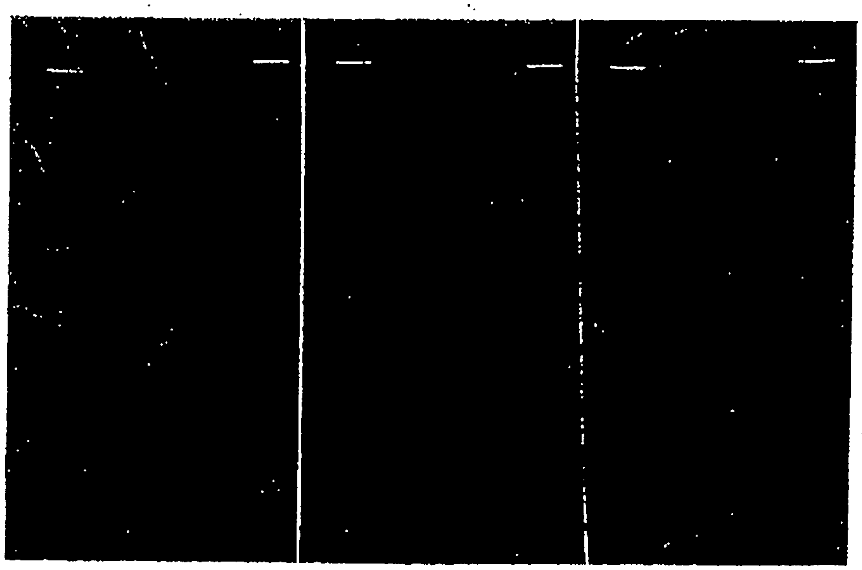

Figure 8. Result of using recycled water glass (obtained from bio purified water glass wastewater) in a dyeing process

Left: Current water glass   Middle: 1/2 Current water glass and 1/2 recycled water glass   Right: Recycled water glass

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